IN THE UNITED STATES PATENT AND TRADEMARK OFFICE BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Appellants:	Paul Thurk, *et al.*
Title:	PHOSPHOR MATERIALS AND ILLUMINATION DEVICES MADE THEREFROM
Appl. No.:	10/814,295
Filing Date:	04/01/2004
Examiner:	Bumsuk Won
Art Unit:	2879
Confirmation Number:	6128

BRIEF ON APPEAL

Mail Stop Appeal Brief - Patents
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Dear Examiner Won:

Under the provisions of 37 C.F.R. § 41.37, this Appeal Brief is being filed in response to the final Office Action dated October 4, 2006, finally rejecting Claims 22-43 and 47-57 of the above-referenced patent application (Application). This Appeal Brief is being filed together with a credit card payment form in the amount of $250.00 covering the 37 C.F.R. 41.20(b)(2) appeal fee for a small entity. If this fee is deemed to be insufficient, authorization is hereby given to charge any deficiency (or credit any balance) to the undersigned deposit account 50-2350.

Appellant respectfully requests reconsideration of the Application.

REAL PARTY IN INTEREST

The real party in interest is Innovalight, Inc., having a place of business at 3303 Octavius Drive, Suite 104, Santa Clara, CA 95054.

RELATED APPEALS AND INTERFERENCES

There are no related appeals or interferences that will directly affect, be directly affected by, or have a bearing on the present appeal, that are known to Appellant or Appellant's patent representative.

STATUS OF CLAIMS

The present appeal is directed to Claims 22-43 and 47-57, all of which stand rejected pursuant to a Final Office Action dated October 4, 2006. Claims 22-43 and 47-57 are being appealed. Claims 1-21 and 44-46 have been cancelled. Claims 1-57 with the appropriate status references are shown in the attached Claims Appendix.

STATUS OF AMENDMENTS

Claims 22-43 and 47-57 were pending in the Application when a Final Office Action dated October 4, 2006, was issued. No amendments have been made in the present Application subsequent to receipt of the Final Office Action dated October 4, 2006. A Notice of Appeal was filed on November 30, 2006.

SUMMARY OF CLAIMED SUBJECT MATTER

Two independent claims, Claims 22 and 47, are under appeal. Claim 22 is directed to a light-emitting device. The device includes a primary light source which emits primary light (para. 42 through 47, FIGS. 3-7) and a phosphor material comprising a plurality of

nanoparticles (para. 25, FIGS. 3-7). The nanoparticles comprise a Group IV semiconductor (para. 31), which absorbs at least a portion of the primary light (para. 48) and emits a secondary light, wherein the secondary light or the combination of the secondary light with the primary light comprises a white light (para. 22 and 58-63).

Claim 47 is directed to a phosphor material. The phosphor material comprises a plurality of domains deposited on an organic film (para. 37). Each domain comprises a plurality of luminescent semiconductor nanoparticles having a substantially monodisperse size distribution (para. 37).

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Six grounds of rejection are presented in this appeal: (1) Claims 22-26, 30-36, 38-40 and 52-56 were rejected under 35 U.S.C. § 103(a) as unpatentable over U.S. Patent Application Publication No. 2003/0067265, filed by Srivastava et al. (hereinafter "Srivastava") in view U.S. Patent Application Publication No. 2005/0266697, filed by Korgel et al. (hereinafter "Korgel"); (2) Claims 27 and 28 were rejected under 35 U.S.C. § 103(a) as unpatentable over Srivastava in view of Korgel and further in view of U.S. Patent Application Publication No. 2003/0186023, filed by Isoda et al. (hereinafter "Isoda"); (3) Claim 29 was rejected under 35 U.S.C. § 103(a) as unpatentable over Srivastava in view of Korgel and Isoda and further in view of U.S. Patent Application Publication No. 2004/0124352, filed by Kashima et al. (hereinafter "Kashima"); (4) Claim 37 was rejected under 35 U.S.C. § 103(a) as unpatentable over Srivastava in view of Korgel and further in view of U.S. Patent Application Publication No. 2004/0105980, filed by Sudarshan et al. (hereinafter "Sudarshan"); (5) Claims 41-43 were rejected under 35 U.S.C. § 103(a) as unpatentable over Srivastava in view of Korgel and further in view of U.S. Patent Application Publication No. 2004/0027062, filed by Shiang et al.

(hereinafter "Shiang"); and (6) Claims 47-49, 51 and 57 were rejected under 35 U.S.C. § 102(e) as unpatentable over U.S. Patent Application Publication No. 2004/0023010, filed by Bulovic et al. (hereinafter "Bulovic").

ARGUMENT

I. LEGAL STANDARDS

A. Standard under 35 U.S.C. § 102(e)

35 U.S.C. § 102(e) provides that:

> A person shall be entitled to a patent unless ... the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

A prior art reference, as defined by 35 U.S.C. § 102, is said to "anticipate" a claimed invention if each and every element of the claimed invention is disclosed, either expressly or inherently, in the prior art reference. *In re Spada*, 911 F.2d 705, 708, 15 U.S.P.Q.2d 1655, 1657 (Fed. Cir. 1990). In deciding the issue of anticipation, one must identify the elements of the claims, determine their meaning in light of the specification and prosecution history, and identify corresponding elements disclosed in the allegedly anticipating reference. *Lindemann Maschinenfabrik v. American Hoist & Derrick Co.*, 730 F.2d 1452, 1458, 221 U.S.P.Q. 481, 485-86 (Fed. Cir. 1984).

The Federal Circuit explained the requirements for anticipation in *Kalman v. Kimberly-Clark Corp.*, 713 F.2d 760, 218 U.S.P.Q. 781 (Fed. Cir. 1983), by stating:

> The law of anticipation does not require that the reference "teach" what the subject patent teaches. Assuming that a reference is properly "prior art," it is only necessary that the claims under attack, as construed by the court, "read on" something disclosed in the reference, i.e., all limitations of the claim are found in the reference, or "fully met" by it.

Id. at 772, 218 U.S.P.Q. at 789.

Extrinsic evidence from those skilled in the art can be used to explain, but not to expand, the meaning of a disclosed element in that single prior art reference, to determine whether the reference anticipates the claims at issue. *In re Baxter Travenol Labs.*, 952 F.2d 388, 21 U.S.P.Q.2d 1281 (Fed. Cir. 1991).

B. Standard under 35 U.S.C. § 103(a)

35 U.S.C. § 103(a) states:

> A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The legal standards under 35 U.S.C. § 103(a) are well settled. Obviousness under 35 U.S.C. 103(a) involves four factual inquiries: (1) the scope and content of the prior art; (2) the differences between the claims and the prior art; (3) the level of ordinary skill in the pertinent art; and (4) secondary considerations, if any, of nonobviousness. *See Graham v. John Deere Co.*, 383 U.S. 1 (1966).

In proceedings before the Patent and Trademark Office, the Examiner bears the burden of establishing a *prima facie* case of obviousness based upon the prior art. *In re Piasecki*, 745 F.2d 1468, 1471-72 (Fed. Cir. 1984). To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine the reference teachings. Second, there must be a reasonable expectation of success. The teaching or suggestion to make the claimed combination and the reasonable expectation of success both must be found in the prior art, not in Appellant's disclosure. *In re Vaeck*, 947 F.2d 488 (Fed. Cir. 1991). Finally, the prior art reference (or references when combined) must teach or suggest all of the claim limitations.

II. REJECTION OF CLAIMS 22-26, 30-36, 38-40 AND 52-56 UNDER 35 U.S.C. § 103(a)

On Page 4 of the Office Action dated October 4, 2006, the Examiner rejected Claims 22-26, 30-36, 38-40 and 52-56 under 35 U.S.C. § 103(a) as unpatentable over Srivastava in view of Korgel. Appellants believe this rejection is improper and should be reversed.

As noted above, the first step in determining the obviousness of a claimed invention is to determine the scope and content of the prior art references. Therefore, it is critical to examine exactly what Srivastava and Korgel do and, perhaps even more importantly, *do not* teach.

Srivastava teaches a white light illumination system that includes a luminescent material which absorbs UV or x-ray radiation from a radiation source and emits visible light. More specifically, Srivastava discloses a very specific phosphor material having a composition $A_{2-2x}Na_{1+x}E_xD_2V_3O_{12}$, wherein: (a) A comprises at least one of calcium, barium, and strontium;

(b) E comprises at least one of the rare earths of europium (Eu), dysprosium (Dy), samarium (Sm), thulium (Tm) and erbium (Er); and (c) D comprises at least one of magnesium and zinc. (Srivastava, para. 22.) In the phosphor material, the rare earth atoms Eu, Dy, Sm, Tm and/or Er act as impurity activators in a rare earth-free host structure. (Srivastava, para. 36 and para. 37.) The overall emission spectrum for the material includes both a broad emission from the host structure and a much narrower emission from the rare earth impurities. (Srivastava, para. 37.) It is this overall emission spectrum that produces a white light emission.

In contrast, Korgel teaches light-emitting devices that include nanoparticles, such as crystalline silicon nanoparticles, in their emissive layer. (Korgel, para. 139.) The nanoparticles of Korgel are very different from the phosphors of Srivastava. Korgel focuses on light-emitting devices wherein light emission from an ordered distribution of nanoparticles is induced by running a *current* across the nanoparticles. (Korgel, para. 0140.) Devices such as these where a current, rather than a primary light source, is used to produce luminescence are known as electroluminescent devices. Electroluminescent devices are fundamentally different from photoluminescent devices which use a primary light source to optically stimulate phosphors to produce a secondary light. Although Korgel briefly mentions the possibility of optically stimulating nanoparticles, no details are provided. In fact, Korgel's disclosure of optical stimulation is limited entirely to two sentences in paragraph 144 which state, "In an embodiment, the nanoparticles may emit light by optical stimulation. In this device, an optical excitations source is used in place of electrical stimulation." Korgel fails to provide any relevant details regarding the photoluminescent properties of the nanoparticles. In particular, Korgel fails to provide any information regarding the excitation and emission spectra of the nanoparticles as a function of excitation wavelength and nanoparticle size.

In light of Korgel's very limited disclosure regarding the luminescent properties of silicon nanoparticles, the Examiner's rejection of Claims 22-26, 30-36, 38-40 and 52-56 is improper and should be reversed because there is no suggestion or motivation to combine the teachings of Srivastava and Korgel, as proposed by the Examiner. Moreover, even if a motivation to combine references could be identified based on the teachings of Srivastava and Korgel, such motivation would not be based on a reasonable expectation of success.

A. The Examiner's rejection of Claims 22-26, 30-36, 38-40 and 52-56 should be reversed because there is no suggestion or motivation to combine the teachings of Srivastava and Korgel.

The Examiner's rejection of Claims 22-26, 30-36, 38-40 and 52-56 is based on the conclusion that that "it would have been obvious to one of ordinary skill in the art at the time the invention was made to use silicon nanoparticles to emit white light disclosed by Korgel in the light-emitting device disclosed by Srivastava, for the purpose of having high efficiency." (Office Action, page 4.) The Examiner draws this conclusion from the simple fact that "Korgel discloses a light-emitting device using silicon nanoparticles to emit white light." (Office Action, page 4.) Thus, the rejection is based on the assumption that one of ordinary skill in the art would recognize that, because the nanoparticles of Korgel are capable (under some unspecified conditions) of emitting white light, the nanoparticles would be readily interchangeable with the $A_{2-2x}Na_{1+x}E_xD_2V_3O_{12}$ phosphors of Srivastava. This amounts to an argument that the nanoparticles of Korgel and the $A_{2-2x}Na_{1+x}E_xD_2V_3O_{12}$ phosphors of Srivastava are functionally equivalent phosphors. Appellants strongly disagree.

"In order to rely on equivalence as a rationale supporting an obviousness rejection, the equivalency must be recognized in the prior art, and cannot be based on

applicant's disclosure or the mere fact that the components at issue are functional ... equivalents." (M.P.E.P.§ 2144.06.) Appellants acknowledge that Korgel discloses a light-emitting device using silicon nanoparticles to emit white light. However, the general teaching that nanoparticles can be used in white light-emitting devices is insufficient to suggest to one or ordinary skill in the art that the nanoparticles of Korgel are interchangeable with the phosphors of Srivastava.

As explained in Srivastava, not all phosphors are functionally equivalent. In fact, many material properties affect the ability of a particular phosphor to provide a secondary light emission through optical stimulation. These material properties include, but are not limited to, the chemical content of the phosphor, the concentration of the phosphor in the material, the absorption efficiency of the phosphor as a function of excitation wavelength (i.e., as a function of the wavelength of the optical excitation source), and the overall bandwidth, intensity and location of the emission spectrum of the phosphor as a function of the excitation wavelength. (See, for example, Srivastava, para. 16-20.) Srivastava characterizes the photoluminescent properties for only a particular, narrow class of phosphors (i.e., the $A_{2-2x}Na_{1+x}E_xD_2V_3O_{12}$ phosphors). Specifically, Srivastava demonstrates that materials that include rare earth atoms of Eu, Dy, Sm, Tm and/or Er in a rare earth-free host structure can be excited by UV light with an excitation wavelength of 370 nm to produce an emission spectrum with a broad emission peak centered around 530 nm from the host structure and a much narrower emission peak centered at 610 nm from the impurities, resulting in a overall emission spectrum that produces a white light emission. (Srivastava, para. 36-39 and figure 3.) There is nothing in the disclosure of Srivastava that suggests silicon nanoparticles would be expected to produce an

equivalent emission spectrum when exposed to the same excitation wavelengths. The disclosure of Korgel fails to remedy this shortcoming.

As discussed above, Korgel provides only a general description of a light-emitting device that incorporates silicon nanoparticles in its emissive layer. Korgel makes some very general statements regarding the average particle diameter of the nanoparticles, the *electroluminescent* wavelengths of silicon nanoparticles having certain diameters, and the possibility of combining different size particles to produce white light in an electroluminescent device. (Korgel, para. 140-141.) However, Korgel provides no specific information about the photoluminescent properties of the nanoparticles. For example, Korgel does not teach or suggest that silicon nanoparticles would have significant absorption efficiencies at the UV wavelengths disclosed by Srivastava. Korgel also fails to provide any information about the individual and/or combined photoluminescence emission peak profiles (including bandwidth and intensity) of the silicon nanoparticles at the UV wavelengths disclosed by Srivastava. Without such information (and in light of the fact that the phosphors or Srivastava and the nanoparticles of Korgel have very different chemical compositions) there would be no reason to believe the silicon nanoparticles of Korgel could be used as substitutes for the $A_{2-2x}Na_{1+x}E_xD_2V_3O_{12}$ phosphors in the devices of Srivastava. Appellants submit that the Examiner's own conclusion that such a substitution is obvious is based entirely on impermissible hindsight gained from the disclosure of Appellant's own patent application.

Because the references cited by the Examiner do not suggest that silicon nanoparticles and $A_{2-2x}Na_{1+x}E_xD_2V_3O_{12}$ phosphors are functionally equivalent, these references fail to provide any suggestion or motivation to replace the phosphors of Srivastava with the

silicon nanoparticles of Korgel, as proposed by the Examiner. For this reason, Appellants respectfully request that the rejection of Claims 22-26, 30-36, 38-40 and 52-56 be withdrawn.

B. The Examiner's rejection of Claims 22-26, 30-36, 38-40 and 52-56 should be reversed because any motivation to combine the teachings of Srivastava and Korgel could not be based on a reasonable expectation of success.

Even if Korgel's general disclosure of a light-emitting device using silicon nanoparticles to emit white light were sufficient to motivate one of ordinary skill in the art to attempt to substitute the phosphors of Srivastava with the silicon nanoparticles of Korgel, that motivation would not be based on a reasonable expectation of success.

The prior art can be modified or combined to reject claims as *prima facie* obvious as long as there is a reasonable expectation of success. Obviousness does not require absolute predictability, however, at least some degree of predictability is required. (M.P.E.P. § 2143.02.) In view of the very limited information about the photoluminescent properties of nanoparticles provided by Korgel, one could not have predicted *a priori* how to successfully produce a photoluminescent white light-emitting device by replacing the Srivastava phosphors with silicon nanoparticles.

As discussed above, the only disclosure in Korgel with regard to the use of nanoparticles in a *photoluminescent* light-emitting device are the bare statements that "nanoparticles may emit light by optical stimulation" and that in these embodiments "an optical excitation source is used in place of electrical stimulation." (Korgel, para. 144.) Korgel provides absolutely no guidance regarding the appropriate emission wavelengths of the optical excitation sources and no information about the light absorption characteristics of the nanoparticles at any

excitation wavelength. While Korgel does make the general observations that the specific wavelength emitted by a silicon nanoparticle may be dependent on the size of the particle (Korgel, para. 140) and that a broad size distribution may be advantageous in that the combination of wavelengths emitted by the different size particles may produce a white light (Korgel, para. 141), Korgel does not provide any information about specific nanoparticle size distributions that could be used to produce a secondary white light emission in response to the absorption of a primary light. Information regarding the appropriate nanoparticles size distribution would require some knowledge about the emission spectrum of the nanoparticles as a function of both the primary light excitation wavelength and particle size. Korgel simply fails to provide such knowledge. In the absence of this knowledge, the combined secondary light emission spectrum for a plurality of silicon nanoparticles as a function of primary light wavelength is unpredictable. Therefore, the motivation to replace the phosphors of Srivastava with the silicon nanoparticles of Korgel could not be based on a reasonable expectation of success. For this reason, Appellants respectfully request that this rejection be withdrawn.

At best, the rationale motivating such a replacement would amount to an improper "obvious to try" rationale. An "obvious to try" standard is not a proper standard for a rejection under 35 U.S.C. § 103. (M.P.E.P. § 2145.X.B) An improper "obvious to try" rationale typically involves two types of cases. "In some cases, what would have been 'obvious to try' would have been to vary all parameters or try each of numerous possible choices until one possibly arrived at a successful result, where the prior art gave either no indication of which parameters were critical or no direction as to which of many possible choices is likely to be successful... . In others, what was 'obvious to try' was to explore a new technology or general approach that seemed to be a promising field of experimentation, where the prior art gives only

general guidance to the particular form of the claimed invention and how to achieve it." (*In re O'Farrell*, 853 F.2d 894, 903, 7 U.S.P.Q.2d 1673, 1681 (Fed. Cir. 1988); cited in M.P.E.P. § 2145.X.B) The Examiner's rationale for rejecting Claims 22-26, 30-36, 38-40 and 52-56 may be described by either of these two types of "obvious to try" cases.

As discussed above, Korgel gives only general guidance to the particular form of the claimed invention and how to achieve it. With only this general guidance, one of ordinary skill in the art would be forced to try each of numerous possible primary light excitation wavelengths and innumerable nanoparticle size distributions until he possibly stumbled upon a white light-emitting device, where the prior art gives no direction as to which of the many possible choices is likely to succeed. This represents a clear instance where the prior art provides nothing more than an "obvious to try" rationale for substituting the phosphors of Srivastava with the nanoparticles of Korgel. Since an "obvious to try" standard is not a proper standard for a rejection under 35 U.S.C. § 103, Appellants respectfully request that this rejection be withdrawn.

III. REJECTION OF CLAIMS 27 and 28 UNDER 35 U.S.C. § 103(a)

On Pages 6 and 7 of the Office Action dated October 4, 2006, the Examiner rejected Claims 27 and 28 under 35 U.S.C. § 103(a) as unpatentable over Srivastava in view of Korgel and further in view of Isoda. Appellants believe this rejection is improper and should be reversed.

Claims 27 and 28 each depend directly or indirectly from Claim 22. Thus, for all of the reasons discussed in Section II, above, with respect to Claim 22, Appellants respectfully

submit that Claims 27 and 28 are also in condition for allowance and respectfully request that this rejection be withdrawn.

Appellants further submit that there is no suggestion or motivation to combine the teachings of Isoda with those of Srivastava and/or Korgel, as proposed by the Examiner. In support of this rejection, the Examiner stated, "Isoda discloses the primary light source is an infrared light source ... It would have been obvious to one of ordinary skill in the art at the time the invention was made to have the primary light source ... disclosed by Isoda in the light emitting device disclosed by Srivastava in view of Korgel ... ." In making this rejection the Examiner has overlooked the fundamental differences between the phosphors of Isoda, the phosphors of Srivastava and the phosphors of Korgel.

Isoda is directed to stimulable activated bromide phosphors that absorb and store radiation and then release the stored energy in the form of a stimulated emission when the phosphor is exposed to a stimulating light, such as infrared rays. (Isoda, para. 2.) As discussed in detail in Section II above, the optical absorption and emission properties of phosphors are very specific to their chemical composition. The phosphors of Isoda have a very different composition from the phosphors in Srivastava or the nanoparticles of Korgel. Thus, the teachings of Isoda with regard to stimulable activated bromide phosphors provide no information or insight into the optical absorption and emission properties of the silicon nanoparticles of Korgel. Therefore, the description of an infrared light source in the context of the Isoda disclosure is insufficient to provide a suggestion or motivation to use that light source in a luminescent device that includes the silicon nanoparticles described by Korgel. For this additional reason, Appellants respectfully request that the rejection of Claim 27 be withdrawn.

IV. REJECTION OF CLAIM 29 UNDER 35 U.S.C. § 103(a)

On page 7 of the Office Action dated October 4, 2006, the Examiner rejected Claim 29 under 35 U.S.C. § 103(a) as unpatentable over Srivastava in view of Korgel and Isoda and further in view Kashima. Appellants believe this rejection is improper and should be reversed.

Claim 29 depends from Claim 27 which depends from Claim 22. Thus, for all of the reasons discussed in Sections II and III, above, with respect to Claims 22 and 27, Appellants respectfully submit that Claim 29 is also in condition for allowance and respectfully request that this rejection be withdrawn.

V. REJECTION OF CLAIM 37 UNDER 35 U.S.C. § 103(a)

On page 8 of the Office Action dated October 4, 2006, the Examiner rejected Claim 37 under 35 U.S.C. § 103(a) as unpatentable over Srivastava in view of Korgel and further in view of Sudarshan. Appellants believe this rejection is improper and should be reversed.

Claim 37 depends from Claim 35 which depends from Claim 22. Thus, for all of the reasons discussed in Sections II, above, with respect to Claims 22, Appellants respectfully submit that Claim 37 also in condition for allowance and respectfully request that this rejection be withdrawn.

Appellants further submit that, contrary to the Examiner's assertion, Sudarshan does not actually teach or suggest a nanoparticle comprising a silicon core and a SiC shell, as recited in Claim 37. In support of this rejection, the Examiner stated:

> Sudarshan discloses a semiconductor core-shell structure wherein the core comprises Si and the shell comprises SiC, for the purpose of protecting the core.
>
> It would have been obvious to one of ordinary skill in the art at the time the invention was made to use the core comprising Si and the shell comprising SiC disclosed by Sudarshan in the light emitting device disclosed by Srivastava in view of Korgel, for the purpose of protecting the core.

Sudarshan discloses core particles having a plurality of coatings. However, Appellants were unable to find any disclosure in Sudarshan suggesting that the coatings were provided "for the purpose of protecting the core," as asserted by the Examiner. Instead, Sudarshan teaches particle cores that are coated for the purpose of providing the particles with multifunctional properties. (Sudarshan, para. 2, 5 and 10.) Although the multifunctional properties are generally described as including magnetic, optical, electrical, biological, lubrication and rheological properties (see, for example, Sudarshan, para. 2), very little information is provided about which specific core/coating combinations provide which multifunctional properties. The only luminescent particles disclosed in Sudarshan are gold and silver particles coated in a polymer matrix. (Sudarshan, para. 59.) Moreover, the only disclosure of coated silicon and germanium particles in Sudarshan relates to water, oil, polyethylene glycol or polymer-coated silicon and germanium particles that may be used to change the transparency of a medium. (Sudarshan, para. 58.) Although silicon and germanium particles are included in a long list of possible core particles (Sudarshan, para. 32) and silicon carbide is included in a long list of possible coatings (Sudarshan, para. 38), Sudarshan provides no suggestion or motivation to coat a silicon or germanium particle with a silicon carbide coating to provide multifunctional properties. For this additional reason Appellants respectfully request that the rejection of Claim 37 be withdrawn.

VI. REJECTION OF CLAIMS 41-43 UNDER 35 U.S.C. § 103(a)

On pages 8 and 9 of the Office Action dated October 4, 2006, the Examiner rejected Claims 41-43 under 35 U.S.C. § 103(a) as unpatentable over Srivastava in view of Korgel and further in view of Shiang. Appellants believe this rejection is improper and should be reversed.

Claims 41-43 each depend directly or indirectly from Claim 22. Thus, for all of the reasons discussed in Section II above, with respect to Claim 22, Appellants respectfully submit that Claims 41-43 also in condition for allowance and respectfully request that this rejection be withdrawn.

VII. REJECTION OF CLAIMS 47-49, 51 and 57 UNDER 35 U.S.C. § 102(e)

On page 3 of the Office Action dated October 4, 2006, the Examiner rejected Claims 47-49, 51 and 57 under 35 U.S.C. § 102(e) as unpatentable over Bulovic. Appellants believe this rejection is improper and should be reversed.

To anticipate a claimed invention, each and every element of the claimed invention must be disclosed, either expressly or inherently, in the prior art reference. *In re Spada*, 911 F.2d 705, 708, 15 U.S.P.Q.2d 1655, 1657 (Fed. Cir. 1990). Appellants respectfully submit that Bulovic fails to suggest, teach, or disclose all of the recited claim elements of Claim 47, from which Claims 48, 49, 51 and 57 depend.

Claim 47 recites, with emphasis added through underlining:

> A phosphor material comprising a <u>plurality</u> of domains deposited on an organic film, <u>each domain comprising a plurality of luminescent semiconductor nanoparticles having a substantially monodisperse size distribution</u>.

In support of this rejection the Examiner asserts, "Bulovic discloses a phosphor material comprising domains (figure 1, 3) disposed on an organic film (4), each domain comprising luminescent semiconductor nanoparticles having a monodisperse size distribution (paragraphs 27-28, for example). (Office Action, page 3.) Thus, it appears that the Examiner is relying on "first layer 3" in figure 1 of Bulovic as a disclosure of a phosphor material comprising a plurality of domains. However, the "first layer 3" in Bulovic does not include a plurality of nanoparticles domains, each comprising a plurality of luminescent semiconductor nanoparticles having a substantially monodisperse size distribution.

First layer 3 of Bulovic is described, in relevant part, as follows:

> First layer 3 can include a plurality of semiconductor nanocrystals, for example, a substantially monodisperse population of nanocrystals. ... A layer that includes nanocrystals can be a monolayer of nanocrystals. (Bulovic, para. 27.)

Thus, at best, Bulovic teaches an organic layer ("second layer 4") having a monolayer of substantially monodisperse nanocrystals disposed thereon. This amounts to the disclosure of an organic layer having a single domain of nanocrystals deposited thereon. Bulovic provides no teaching or suggestion that the monolayer of nanocrystals should be divided into a plurality of domains on the organic layer. To the contrary, Bulovic suggests that the monolayer should be made up of nanocrystals having a monodisperse size distribution. (Bulovic, para. 27.)

Claim 47 specifically recites a phosphor material comprising a plurality of domains deposited on an organic film, each domain comprising a plurality of luminescent semiconductor nanoparticles having a substantially monodisperse size distribution, and hence each domain capable of emitting a single color. One example of what is possible with such a configuration is found in the instant application, paragraph 37:

> "...For example, domains of red-emitting nanoparticles, domains of blue-emitting nanoparticles, and domains of green emitting (sic) nanoparticles may be deposited atop an organic film."

Therefore, Bulovic fails to teach each and every limitation of Claim 47. For this reason, Appellants respectfully request that the rejection of Claim 47, and of Claims 48-51, which depend therefrom, be withdrawn.

CONCLUSION

In view of the foregoing discussion and arguments, Appellants respectfully submit that Claims 22-43 and 52-56 are not properly rejected under 35 U.S.C. 103(a) as obvious over the cited prior art. Appellants further submit that Claims 47-51 and 57 are not properly rejected under 35 U.S.C. 102(e) as anticipated by the cited prior art. Accordingly, Appellants respectfully request that the Board reverse all claim rejections and indicate that a Notice of Allowance respecting all pending claims should be issued.

Respectfully submitted,

Date January 26, 2007

By

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CLAIMS APPENDIX

1-21. (Canceled)

22. (Original) A light emitting device comprising:

(a) a primary light source which emits primary light; and

(b) a phosphor material comprising a plurality of nanoparticles, the nanoparticles comprising a Group IV semiconductor, which absorbs at least a portion of the primary light and emits a secondary light, wherein the secondary light or the combination of the secondary light with the primary light comprises a white light.

23. (Original) The light emitting device of claim 22, wherein the primary light is ultraviolet or blue light.

24. (Original) The light emitting device of claim 22, wherein the primary light comprises wavelengths of from 320 nm to 480 nm and the secondary light has a lower energy than the primary light.

25. (Original) The light emitting device of claim 24, wherein the primary light source is a blue light emitting diode or an ultraviolet light emitting diode.

26. (Original) The light emitting device of claim 23, wherein the primary light source is a fluorescent lamp.

27. (Original) The light emitting device of claim 22, wherein the primary light source is an infrared light source and the secondary light has a higher energy than the infrared light.

28. (Original) The light emitting device of claim 27, wherein the primary light source is a red light emitting diode.

29. (Original) The light emitting device of claim 27, wherein the primary light is a halogen lamp or an incandescent lamp.

30. (Original) The light emitting device of claim 22, wherein the nanoparticles have an average particle diameter of from about 1 to about 150 angstroms.

31. (Original) The light emitting device of claim 22, wherein the phosphor material has an emission profile comprising emission peaks in the green to red regions of the visible spectrum.

32. (Original) The light emitting device of claim 22, wherein the phosphor material has an emission profile comprising emission peaks in the blue to red regions of the visible spectrum.

33. (Original) The light emitting device of claim 22, wherein the Group IV semiconductor is silicon.

34. (Original) The light emitting device of claim 22, wherein the Group IV semiconductor is germanium.

35. (Original) The light emitting device of claim 22, wherein the nanoparticles comprises core/shell nanoparticles comprising a Group IV semiconductor core and an inorganic shell.

36. (Original) The light emitting device of claim 35, wherein the inorganic shell comprises ZnS or CdS.

37. (Original) The light emitting device of claim 35, wherein the core comprises silicon and the shell comprises Si_3N_4 or SiC.

38. (Original) The light emitting device of claim 35, wherein the core comprises silicon and the shell comprises Ge.

39. (Original) The light emitting device of claim 35, wherein the core comprises germanium and the shell comprises Si.

40. (Original) The light emitting device of claim 22, wherein the nanoparticles are dispersed in a binder.

41. (Original) The light emitting device of claim 22, wherein the primary light source comprises an electroluminescent device.

42. (Original) The light emitting device of claim 22, wherein the primary light source comprises an organic light emitting material.

43. (Original) The light emitting device of claim 42, wherein the nanoparticles are dispersed in the organic light emitting material.

44-46. (Canceled)

47. (Previously Presented) A phosphor material comprising a plurality of domains deposited on an organic film, each domain comprising a plurality of luminescent semiconductor nanoparticles having a substantially monodisperse size distribution.

48. (Original) The phosphor material of claim 47, wherein the organic film has a plurality of luminescent nanoparticles dispersed therein.

49. (Previously Presented) The phosphor material of claim 48, wherein the luminescent nanoparticles dispersed in the organic film have a substantially monodisperse size distribution.

50. (Previously Presented) The phosphor material of claim 48, wherein the luminescent nanoparticles dispersed in the organic film have a polydisperse size distribution.

51. (Previously Presented) The phosphor material of claim 47, wherein the domains have dimensions of no more than about 100 microns.

52. (Previously Presented) The light emitting device of claim 22, wherein the Group IV semiconductor is doped with impurities.

53. (Previously Presented) The light emitting device of claim 22, wherein the nanoparticles are embedded in an inorganic binder.

54. (Previously Presented) The light emitting device of claim 22, wherein nanoparticles comprising a Group IV semiconductor are SiGe alloy nanoparticles.

55. (Previously Presented) The light emitting device of claim 22, wherein the white light has a color rendering index of at least 90.

56. (Previously Presented) The light emitting device of claim 22, wherein the device produces white light with an efficiency of at least 30 lm/w.

57. (Previously Presented) The phosphor material of claim 47, wherein the plurality of domains comprise a monolayer of nanoparticles.

EVIDENCE APPENDIX

None.

RELATED PROCEEDINGS APPENDIX

None.